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Dietary diversity and nutritional status of children aged 6–59 months from rural fishing and non-fishing communities in Zambia

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Low-quality complementary foods combined with inappropriate feeding practices put children under the age of five in developing countries at high risk for undernutrition. This study explored dietary diversity, fish consumption patterns and nutritional status of children in Luapula, a rural province in Zambia, where households rely on capture fisheries for their livelihoods. In the cross-sectional study, households with children aged 6–59 months were enrolled in the study. A semi-structured questionnaire was utilised to collect socioeconomic characteristics, dietary intake and anthropometric data. Descriptive statistics and bivariate associations were conducted. 23% of children aged 6–23 months met the minimum dietary diversity. About 49% and 41% of the children were fed on fresh small pelagic fish and large dried fish once to twice a week, respectively. Imbilya *(Serranochromis mellandi*), Chisense (*Poecilothrissa moeruensis),* and amatuku (*Tilapia sparrmanii*) were the most preferred fish species due to their availability and affordability. Only 3.5% of children consumed porridge to which fish powder had been added. There was a significant difference in the height for age z scores of children in the two communities ($\chi^2 = 12.404$; $p = 0.002$, d.$f = 2$). Low dietary diversity was observed across the fishing and non-fishing communities and less than half of the children consumed fish despite proximity of the study sites to one of the largest water bodies in Zambia. Better nutrition outcomes were observed among children in capture fisheries dependent households. Nutrition education in growth monitoring and promotion centres should address the issue of adequacy of diets with regard to frequency and diversity.

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Introduction

Childhood undernutrition remains a major health problem in resource-poor settings. Despite reported reductions in childhood stunting, approximately 22.2% of all children under five years globally are stunted and 50.5 million are wasted; while an estimated 16 million are experiencing both stunting and wasting [1, 2]. It is believed that at least 124 countries worldwide face more than one form of malnutrition (undernutrition, overnutrition, micronutrient deficiencies); with 41 countries experiencing all three forms. Across Africa, childhood stunting increased from 50.6 million in 2000 to 58.7 million in 2017 [1, 2]. Poor maternal and infant and young child feeding practices have been linked to these high levels of malnutrition [3]. Among the 6 – 23 year olds breast milk alone is insufficient to meet energy and micronutrient needs, hence the need to introduce suitable complementary foods. Consequently, improving maternal, infant and young child nutrition is one of the strategies for reducing malnutrition among the mother-infant dyads/pairs. Low-quality complementary foods combined with inappropriate feeding practices put children under the age of two in developing countries at high risk for undernutrition and its associated outcomes. Stunting prevalence in Zambia varies by province; ranging from 46% in the Northern province, to 29% in the Western and Southern provinces. Data from the Zambia Demographic Health Survey shows a decrease in childhood stunting from 40% in 2014 to 35% in 2018; as well as wasting from 6% to 4% and underweight from 15% to 12% [4]. Generally, childhood stunting in Zambia ranges between 38% and 45% during the first 15 to 45 months of a child's life. Stunting was observed to be most prevalent within the first 22 months, followed by a decline in prevalence at 32 months. The last decline in prevalence is seen between the 58th and 59th month [4]. Children from rural areas remain most at risk.

Fish is an important source of protein and contains key micronutrients that play a crucial role in infant and young child development [5–7]. These include long chain omega-3 polyunsaturated fatty acids (LC*n*-3PUFAs), vitamins A, D and B12, iodine and selenium. Globally, fish accounts for nearly 20% of the average per-capita intake of animal protein for about three billion people; and contributes to approximately 22% of the protein intake in Sub-Saharan Africa[8, 9]. Fish consumption is associated with significant foetal health benefits including reduced risk of spontaneous abortion, increased birth weight and improved neurodevelopment[10]. The US Food and Drug Administration (FDA) recommends consumption of 8–12 ounces (2–3 servings) of lower-mercury fish per week for pregnant or lactating women, to ensure optimum infant growth [11]. This is supported by evidence that shows this quantity can lead to significant improvements in foetal neurodevelopment, as well as childhood developmental scores in language and social activity between the ages of 15 to 18 months[10].

The findings in this study explore dietary diversity, fish consumption patterns and nutritional status of children in Luapula province. It is one of the rural provinces in Zambia where households rely on fisheries for their livelihoods [12, 13]. It is unclear whether a household's involvement in fishing translates to increased fish consumption. There is paucity of detailed data describing the association between fish consumption, dietary diversity and nutritional status of children of ages 6- 59 months among household's involved in fishing. In the current study, we sought to investigate whether there was an association between dietary diversity and nutritional status of children aged 6–59 months from rural fishing and non-fishing communities in Zambia. We also establish fish consumption among children aged 6–59 months given that fish is one of the locally available animal source foods in the region.

Materials and methods

Description of the study site and research design

Luapula province in Zambia was purposively selected for the study due to the high poverty levels, high undernutrition rates among children and has communities that rely on fishing and agricultural practices for their livelihood. Luapula province has a landmass of 51,000 km^2. The province forms boundary with the Democratic Republic of Congo (DRC) on its southern, south-western and northern sides, with Northern province on the eastern side and Central province on the south-eastern side. Administratively, the province is divided into eleven districts, namely, Chienge, Chifunabuli, Kawambwa, Mansa, Milenge, Mwense, Nchelenge, Chembe, Mwansabombwe, Lunga, Chipili and Samfya. Mansa is the provincial headquarters. The population of Luapula province is 1265,234 as per the 2018 population census. In this province, majority of fishing activities take place in Lake Bangweulu, Lake Mweru, Lake Chifunabuli, and River Luapula. There are initiatives by the government of Zambia, WorldFish center, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and other partners to promote aquaculture in the province, but most of it is still its infancy stage. In Luapula province, approximately 17.2% of households are involved in fishing and selling of fish from streams, rivers and lakes [14]. Cassava is the main food crop grown. The province has also diversified into maize production due to reliable rainfall patterns. Other crops grown include millet, tobacco and groundnuts. A descriptive, cross-sectional study design was used. Fishing communities and those predominantly involved in agricultural activities (referred to as non-fishing communities) from Samfya district were targeted. Samya district is one of the districts which lies along the Lake Bangweulu fishery.

Sample size, inclusion and exclusion criteria

A sample of 203 mother-child pair was determined using the Fisher's formula, $N = Z^2 \pi (1- \pi)/ d^2$, where N = required minimum sample size; Z = z value of desired level of confidence, π = population proportion of interest (for this study, proportion of children aged 6 – 23 months who consumed 4+ food groups in Luapula province was used), d = acceptable margin of error. Given a 95% confidence level, 0.92% as population proportion of interest, and a margin of error of +/- 5%, the sample size was estimated as $N= (1.96)^2 * 0.092 (1-0.092)/0.05^2$. The minimum sample size required for this study was 128 households with children aged 6–59 months given a simple random sampling. To take care of design effect for 2 stage cluster sampling (2SC), attrition and non- response, the sample size was adjusted to 203 households. To arrive at the sample size, first, Samfya district was purposively selected from the 12 districts in Luapula province. Communities situated along the Lake Bangweulu and those in the agricultural regions of Samfya were identified with the assistance of staff at the Department of Fisheries in Samfya and Ministry of Health Provincial Nutritionist in Luapula province. The list of communities formed the clusters from which four communities were randomly selected (two from the fishing communities and two from the non-fishing communities). The selected communities were Katansha, Mundubi (fishing communities), Isamba and Mungulube (non-fishing communities). Qualifying households with mother child dyads were identified with the help of community health workers from each of the communities. The children were aged 6 months to 59 months. Sick children were excluded from the study. The qualifying households formed the sampling frame. Simple random sampling was then applied to arrive at the sample size.

Data collection

A questionnaire comprising sub-sections with questions on respondent demographic and socioeconomic characteristics, fishing and fishing-related activities was used to collect the data. A food frequency questionnaire and paper based multiple-pass 24 hour recall were used to collect food consumption data on mothers and children of ages 6–59 months. The 24 hour recall included three stages: first, the mother provided a “quick list” of foods consumed by the child 24 hour prior to the study. This was followed by a “detailed description of food and beverage items consumed” and in the third stage a “review” of foods consumed was done. The development of the 24 hour recall was based on the methods described by Gibson and Ferguson [15]. Anthropometric measurements such as weight and length/height were taken on the children participating in the study, to help determine children’s nutritional status. The weights of children were taken using the SECA electronic scale, and for those children who were unable to stand, the 2 in 1 SECA scales (S-876) were used to take the measurements and weight of the child determined accordingly. The children’s weights were taken to the nearest 0.1 kg with minimal clothes on them. Length/height boards were used to take the length/height to the nearest 0.1 cm. Children’s age was verified using the children’s clinic cards.

Data analysis

The statistical Package for Social Sciences (version 21) was used to analyze the quantitative data. Descriptive statistics were used to describe the data. Using data collected from the 24 hour recall, the individual dietary diversity score was determined using the 7 food items based on the WHO food group categorization [16, 17]. The 7 foods groups used for calculation of this indicator are: a) grains, roots and tubers, b) legumes and nuts, c) dairy products (milk, yogurt, cheese), d) flesh foods (meat, fish, poultry and liver/organ meats), e) eggs, f) vitamin-A rich fruits and vegetables, and g) other fruits and vegetables. The minimum dietary diversity score (MDDS) which is the proportion of children 6–23 months of age who receive foods from 4 or more food groups[18, 19]; was determined separately and the MDDS for children aged 24 – 59 months was also determined. MDDS was a dichotomous variable; Yes=1, if the child consumed foods from 4 or more food groups; and No=0, if a child consumed foods from less than 4 food groups. Currently, there is no indicator to assess nutrient adequacy in children older than 23 months. Anthropometric measurements for children aged 6 months to 59 months were used in the calculation of three anthropometric indices: height-for-age (HAZ), weight for height z scores (WHZ) and weight-for-age (WAZ) using WHO Anthro v.3.2.2. Differences between groups were done using *t*-test and chi square test for continuous data and proportions, respectively. Bivariate association was assessed using Pearson correlation and Spearman rank order correlation for selected variables. P values<0.05 were considered statistically significant.

Results

socio-economic and demographic characteristics

Analysis in this paper is based on data collected from a total of 198 households (HH) with child-mother pair who participated in the study. Five households were excluded from the analysis for incomplete information on key variables of interest. Out of the 198 respondents, 98 of them were from the fishing communities while 100 were from the non-fishing communities (Table 1).

A total of 129 (65.2%) children were aged between 6 and 23 months, while 69 (34.8%) of them were aged 24 – 59 months; and 118 children (59%) of the children were female and 82 (41%) were male. Notable differences between the two communities were on age, education, marital status as well as engagement in fishing related activities (as fishermen, fish mongers). A low proportion (14%) of respondents from non-fishing communities reported involvement of their household members in fisheries related activities. The main income generating activity in both fishing and non-fishing communities was selling of farm produce.

Table 1
socioeconomic and demographic characteristics of survey participants [a,b].

Variable	Communities		p-value
	Fishing, n (%)	Non-fishing, n (%)	
Number of mothers (N)	98	100	
Age of mother	27.5 ± 7.6	30.7 ± 7.8	0.004
Education level of mothers, n (%)			
None	10 (10)	8 (8)	0.050
Primary	63 (64)	80 (79)	
Secondary	25 (26)	13 (13)	
Marital status of the mothers			
Single	17 (17)	3 (3)	0.011
Married	73 (75)	92 (91)	
Others	8 (8)	6 (6)	
Members of HH above 5 years	4 ± 2	5 ± 2	0.003
Occupation of mothers, n (%)			
Farming	62 (67)	63 (63)	0.016
Shopkeeper	10 (11)	11 (11)	
Housewife	13 (14)	26 (26)	
Civil Servant	1 (1)	0	
Fishmonger	7 (8)	0	
Involvement in fisheries activities	30 (31)	14 (14)	0.007

[a] Values are means ± Standard Deviations and were compared by *t*-test.
[b] Proportions were compared by chi-square test.

Table 2
Household assets.

Variable	Communities		P-value
	Fishing, n (%)	Non-fishing, n (%)	
Bicycle	50 (51.0)	45 (45.0)	0.361
Motorcycle	1 (1.0)	1 (1.0)	0.983
Car	2 (2.0)	0	0.149
Solar panel	16 (16.3)	10 (9.9)	0.179
Car battery	11 (11.3)	13 (12.9)	0.741
Mobile phone			
None	12 (12.5)	52 (51.5)	0.000
One	79 (82.3)	40 (39.6)	
≥ Two	5 (5.2)	9 (8.9)	
Radio			
One	59 (61.5)	23 (23.0)	0.000
Two	26 (27.0)	74 (74.0)	
≥ three	11 (11.5)	3 (3.0)	
Household ownership of fishing gear (nets, boats, hooks, etc.)			
One	9 (21.6)	8 (7.9)	0.013
Two	85 (86.7)	92 (93.0)	
≥ three	4 (4.08)	0	
Ownership of cultivable land/ homestead land	1.3 ± 0.5	6.6 ± 14.2	0.000

On asset ownership (Table 2), there was a significance difference in mobile phone ownership ($p = 0.00$), radio ownership ($p = 0.00$) and fishing gear ownership (0.013) between fishing and non-fishing communities. A higher proportion of households from the fishing communities had mobile phones compared to the non-fishing communities (82% vs 40%); and 75% of the households in the fishing communities owned two fishing gears.

Food consumption patterns

At the time of the study, a higher proportion of children (68%) from the fishing communities were breastfed, compared to 48% from the non-fishing communities. The mean number ± SD of breastfeeds per day were 9 ± 4 and 7 ± 3 among the fishing and non-fishing communities, respectively. Table 3 summarizes consumption of food groups consumed by children aged 6–59 months in the fishing and non-fishing communities in the last 24 h. Almost all children consumed food from the grains, roots and tubers group. Vitamin (Vit) A-rich fruit and vegetables was the second most consumed food group, followed by the legumes. Forty seven (47%) of children from the non-fishing communities consumed flesh foods in the last 24 h prior to data collection exercise, compared to 30% of children from the fishing communities. Chi-square test established significant differences in the consumption of “other fruits and vegetables,” flesh foods and other fruits and vegetables groups by children in the two communities. Dairy products and eggs were seldom consumed by children in the study site.

Table 3
Food consumption patterns of children aged 6–59 months in the last 24hours.

Variable	Communities			p-value
Food group	Fishing n (%)	Non-fishing n (%)	Total N (%)	
Grains, roots and tubers	91 (92.9)	95 (95)	186 (93.9)	0.528
Legumes and nuts	30 (30.6)	44 (44)	74 (37.3)	0.052
Dairy products	5 (5.1)	13 (13)	18 (9.0)	0.053
Flesh foods	30 (30.6)	47 (47)	77 (38.9)	0.018*
Eggs	10 (10.3)	13 (13.0)	23 (11.6)	0.509
Vit A-rich fruits and vegetables	48 (49.5)	49 (50.5)	97 (48.9%)	0.019*
Other fruit and vegetables	33 (34)	15 (15)	48 (24.2)	0.002*

* denotes significant at 95% confidence level.

Table 4
Fish mostly consumed by children in the week preceding the survey.

Fish speciesLocal name (Scientific name)	Fishing community $n = 98$, (%)	Non-fishing community $n = 100$, (%)	Total N (%)	p-value
Chisense (*Poecilothrissa moeruensis*)	44 (45.0)	10 (10)	59 (29.7)	0.000
Imbilya (*Serranochromis mellandi*)	46 (46.9)	49 (49)	95 (47.9)	0.562
Amatuku (*Tilapia sparrmanii)*	37 (37.8)	35 (35)	72 (36.4)	0.58
Tiger fish (*Hydrocynus vittatus)*	4 (4.2)	1 (1)	5 (2.5)	0.182
Imintesa *(Marcusenius macrolepidotu*)	2 (2.0)	4 (4)	6 (3.0)	0.385

Fish consumption among children aged 6–59 months

The study sought to establish the most commonly consumed animal source food one week prior to the survey and frequency of consumption of these foods. Fresh small fish and large dried fish were the most commonly consumed animal-source foods by most children; with 49% and 41% of the mothers reporting to have fed children either of these fish once to twice a week, respectively. Other than fish, poultry and eggs were also consumed by children at least once to twice a week. The age at which children in the study sample started consuming fish; and the form in which the fish was consumed were explored. Most mothers reported to have introduced fish to their children at the age of 7 months. Fish consumed by children was in the form of "soup and fillet" (45.9%) followed by "soup only" (34.3%), whole small fish (52%) and mashed fish fillet (4.5%). A small proportion (3.5%) of children consumed porridge to which fish powder had been added.

Mothers were asked to indicate the fish species that were mostly consumed in the week prior to the study by children. Overall, a high proportion of children were fed on Imbilya *(Serranochromis mellandi)*, followed by Chisense *(Poecilothrissa moeruensis.* Amatuku (*Tilapia sparrmanii*) was the third most preferred fish species (Table 4). The study sought to explore why the specific fish species were preferred for consumption. A high proportion of the mothers indicated that availability of the fish (73.5%, $n = 144$), affordability (55.1%, $n = 108$) were key in deciding which fish species to cook for their children. Few mothers reported that taste (23.9%, $n = 47$) and ease of preparation (11.2%, $n = 22$) were factors that were considered when considering fish to be prepared for the children. Tiger fish (*Hydrocynus vittatus)* was avoided by mothers because it had many small bones and posed high choking risk to the children. Fish consumed by children was mostly boiled.

Minimum dietary diversity score for children aged 6 – 59 months

Overall, most children (72%, $n = 142$) did not meet the minimum dietary diversity (MDD). The mean MDD score was 2.85 (± 1.24) with a minimum dietary diversity score of 1 and maximum DDS of 6. In the fishing communities, the proportion of children meeting the minimum dietary diversity was 17% and 32% for children aged 6–23 months and 24–59 months, respectively. In the non-fishing communities, only about a quarter (23%) of children aged 6–23 months met the minimum dietary diversity, while more than half (52%) of the children aged 24–59 months in the same communities met the minimum dietary diversity. Older children in the non-fishing communities had a more diversified diet compared to children of the same age from the fishing communities. A chi square test showed no statistically significant difference in the dietary diversity of children aged 6-23 months and those aged 24–59 months (χ^2 =0.242; $p = 0.623$). However, there was a significant difference in the dietary diversity among children in the fishing and non-fishing communities ((χ^2 =4.125; $p = 0.042$).

Nutritional status of children

Table 5 shows the HAZ, WAZ, WHZ indices for children in the two communities. Out of the 198 children, 65% ($n = 129$) were found to be within the normal range for HAZ scores; 19.2% of children ($n = 38$) were moderately stunted and 15.7% ($n = 31$) were severely stunted. About 9.6% of the children were moderately underweight and 3.5% of the children were wasted.

Table 5
HAZ, WAZ and WHZ Indices.

Height for Age Z scores (HAZ)	Frequency (n)	%
Mean HAZ	−1.15 (± 2.12)	
Normal	129	65.2
Moderately stunted	38	19.2
Severe stunting	31	15.7
Total	**198**	**100**
Weight for Age (WAZ)		
Mean WAZ	−0.67 (± 1.35)	
Normal	164	82.8
Moderate underweight	19	9.6
Severe underweight	7	3.5
Overweight	8	4
Total	**198**	**100**
Weight for Height (WHZ)		
Mean WHZ	2.02 (± 0.427)	
Normal	162	81.8
Wasting	16	8.1
Overweight	20	10.1
Total	**198**	**100**

Overall, children in the fishing communities were better off in terms of all the three nutritional indices (HAZ, WAZ and WHZ) compared to those from the non-fishing communities. This was apparent in all the three indices used to measure child nutritional status. The comparison of HAZ scores for children aged 6–59 months old in the non-fishing and fishing communities showed that 53% and 78% of the children respectively were within the normal range of HAZ scores (not stunted). A higher proportion of children from the non-fishing communities suffered from moderate (26%) and severe (21%) stunting compared to those children from the fishing communities (severe stunting, 10%; moderate stunting, 12%). Proportions of children aged 6 - 59 months old from the non-fishing and fishing communities that fell in the various weight for age (WAZ) score categories were; normal, 81% and 85%; overweight, 4% for both; moderate underweight 10% and 9%; severe underweight 5% and 2%. On the other hand, proportions of children aged 6 - 59 months old from the non-fishing and fishing communities that fell in the various weight for height (WHZ) score categories were; normal, 70% and 85%; wasting, 9% for both; overweight, 21% and 6%. There was a significant difference in nutritional status of children as measured by the HAZ scores between the fishing and non-fishing communities (χ^2= 12.404; p = 0.002, d.f = 2). No significant differences were observed with regards to underweight and wasting among children in the two communities.

Nutritional status by sex and age of the child

Out of the 198 children that participated in the study, a total of 118 children (59%) were female and 82 (41%) were male. Chi-square test to determine differences in stunting, wasting and underweight by sex of the child revealed a significant difference in stunting by sex of the children (p = 0.045). Male children were found to be worse off than female children in HAZ scores. There were no significant differences in the WAZ and WHZ scores by sex of child.

A total of 129 (65.2%) children were aged between 6 and 23 months, while 69 (34.8%) of them were aged 24 – 59 months. Pearson correlation coefficient (r) was used to establish the existence of a relationship between stunting and age of child; and the direction of that relationship. There was a negative relationship between age of child and the HAZ scores; and was significant at 0.01 level (r =−0.379). With increase in age, the child's nutritional status got worse (i.e. lower HAZ scores with increase in age). There was a weak positive relationship between WHZ scores and age, r = 0.073. The correlation was insignificant at 0.05 level (p = 0.306). There was a negative correlation between weight for age z scores and age of child (r =−0.253; at 0.001 level). Children who were older tended to be thinner for their age.

Spearman correlation coefficient (rho) was used to establish the existence of correlation between children's nutritional status and dietary intake as measured by the dietary diversity score. There was a weak negative correlation between HAZ and dietary diversity score (Spearman rho coefficient = −0.06, p = 0.399) and a weak positive correlation between WAZ and dietary diversity (Spearman rho coefficient =0.116, p = 0.104). In both cases, the correlation was not significant. Similarly, there was an insignificant negative association between dietary diversity and WHZ (Spearman rho coefficient = −0.002, p = 0.977).

Prevalence of malaria, diarrhea and other illnesses among children 6- 59 months

Mothers were asked to report whether their children had suffered from malaria, cough, flu, diarrhea, fever or other illnesses two weeks preceding the data collection exercise. Responses for a total of 198 children were obtained. Overall, about 38.9% (n = 77) and 44.4% (n = 88) of the children were reported to have suffered from malaria, cough and flu, two weeks preceding the data collection exercise, respectively. More than a quarter of the children (34.8%, n = 69) suffered from diarrhea. More children from the non-fishing communities were reported to have suffered from malaria (48%), cough and flu (53%), two weeks prior to the survey. The differences in the proportion of children suffering from malaria; cough and flu in the fishing and non-fishing communities were significant at $p = 0.011$ and $p = 0.009$), respectively. There was also a significant difference in the proportion of children who suffered from fever in the two communities.

Discussion

As informed by the findings, most households in the study site belong to the low socioeconomic status although households in the fishing communities had a better socioeconomic status based on asset ownership as compared to those from the non-fishing communities; with few owning assets such as mobile phones, radio and television. Socioeconomic status (SES) particularly low household SES is associated with unhealthy behaviours including poor diet and adverse health outcomes [20]. Thus, whereas over 93% of children from both communities (fishing and non-fishing) consumed food from the grains, roots and tubers group, this was not surprising. This is so because maize is the staple food in Zambia and cassava is one of the most cultivated and consumed food crop in Luapula province [21, 22]. Nationally in Zambia, the consumption of eggs, dairy and flesh foods are estimated to be at 14.3%, 4.7% and 26.8%, respectively [4]. Across both communities, flesh foods (meat, poultry and fish) were consumed by a small proportion of children (38.9%); eggs and dairy products were seldom consumed. Moreover, eggs and dairy products were seldom fed to children; and less than half of the children consumed Vitamin A rich fruits and vegetables. It is worth noting that Luapula province is one of the provinces in Zambia with high Vitamin A, iron, and Zinc deficiencies among children [4, 23]. The province has the highest prevalence of anemia in Zambia, estimated at 71% [4]. Viewed together, the findings of this study point to the low quality of diets consumed by children that could be contributing to the overall high micronutrient deficiencies in the province.

In relation to the low socioeconomic status established among the household in both communities, our study further observed that, among the animal source foods, small pelagic fish (mostly *chisense*) was the most consumed by children. Similar findings in Bangladesh showed fish as the most consumed animal source food among vulnerable groups with comparable trends noted in Indonesia, rural Nepal, and urban Zambia [24–26]. Also, high consumption of fish has been reported in a fishing village in Ghana where 80% of children younger than five years (198/250) consumed fish products more than three times per week [27]. There was a further variability in fish consumption by children in fishing and non-fishing communities with regard to fish species consumed. *Chisense, imbilya and amatuku* fish species were the most preferred fish species. This consumption trend is indicative of availability and affordability of fish for local households, as some of the factors affecting consumption of fish in rural areas in Zambia and the broader great lakes region [6, 28]. Despite fish being the most consumed animal source food in this study, a small proportion of children were reported to have consumed fish, yet fish is locally available in the study site. The phenomenon resonates with findings that have underscored how locally available food supplies such as fish vis-a-vis demand directed toward external markets reduce availability and affordability of such food supplies for local households leading to an influence on dietary patterns with limited consideration on nutritional benefits [24, 28, 29]. For instance, although fish was a locally available and nutritious animal-source food, the overall dietary pattern of children was dominated by staples, less frequent consumption of fruits and vegetables, and regular consumption of low-nutrient dense and processed snack foods [24].

In as much as a high proportion of children failed to meet the minimum dietary diversity, a higher proportion of older children in the non-fishing communities had a more diversified diet compared to children of the same age from the fishing communities. This can be attributed to participation in farming activities, contribution of farm produce to the diet as well as availability/accessibility of other food crops for sale in the non-fishing communities [29]. Low dietary diversity remains a challenge in Luapula province and throughout Zambia largely due to dependence and government's favorable policy on maize production. According to the 2018 Zambia Demographic Health Survey, only 13% of children aged 6–23 months met the criteria for a minimum acceptable diet; and 23% of children met the minimum dietary diversity score [4]. In our study, the proportion of children that met the minimum dietary diversity was found to be slightly higher (28%) in comparison to the 20.2% for Luapula province reported in 2018 [4]. The low dietary diversity among children in Luapula province is of concern as it is below WHO's recommendations on minimum dietary diversity.. Dietary diversity in early childhood is associated with improved growth and development, and vegetables, fruit and animal source product consumption should be encouraged among young children [25]. Also, inadequate dietary diversity is considered a significant predictor of stunting among children aged 6 to 23 months [30].

The age at which children in the study sample started consuming fish and the form in which the fish was consumed were explored. In both fishing and non-fishing communities, children started consuming fish at similar ages of 7.7 months and 7.8 months, respectively. Prior studies conducted in Zambia reported that almost half (46%) of the children started eating fish at the age of 6 months [6], an age slightly below the age [7months] at which children started consuming fish in Samfya district. In both communities, the forms in which the fish was consumed most by children were "soup" and "fillet," "soup only" and "whole small fish". Only a small proportion of children had fish powder added to their porridge. The use of dried fish powder in homemade porridges for children remained low despite Zambia government promotion of the same for over 10 years [23]. More recently, in Eastern and Central Zambia, the International Potato Center developed a number of complementary food recipes with vitamin A-rich orange sweet potato, dried fish and beans [6, 31]. The World Fish, developed a fish based recipe book for children's complementary foods [6, 31] and together with Self Help Africa and the National Food and Nutrition Commission conducted cooking demonstrations in several provinces of Zambia. Research insights to examine and monitor uptake of these initiatives should be encouraged to ensure their targeted objectives are attained.

Wasting and underweight herein observed was of medium public health significance according to WHO classification [32, 33]. A stunting prevalence (combination of moderate and severe stunting) of 35% is of high public health significance, while wasting (of 8.1%) was of medium public health significance [32, 33]. Likewise, the proportion of stunted children in the two communities (Table 5) were below those reported in the 2018 ZDHS report for Luapula province (i.e. 16.9% for severe stunting and 44.9% for moderate stunting) [4] with lower prevalence trends for underweight as well. Equally, the reported prevalence of stunting, wasting and underweight in the two communities were below the national estimates of 35% (stunting), 4% (wasting) and 12% (underweight); and provincial level prevalence rates for the three indices (HAZ (44.9%), WHZ (2.2%) and WAZ (12.1%) as reported by the Zambia Statistical Agency[4]. In relation to other fishing communities for instance the lake region of Kenya, it was reported that 31% of children aged 6 – 23 months were stunted and 10% were wasted; despite 97% of mothers reporting fish consumption by children over a three day period, with a mean consumption of 178 g [34]. Similarly in a Ghanaian study, a stunting prevalence of 17.6% was reported among children aged 6 – 59 months, despite high fish consumption [27]. The association between fish consumption and stunting in these fishing communities of low socioeconomic status are consistent with our reported trends where, stunting was the most common form of malnutrition, with the highest prevalence observed in children aged between 24 and 35 months. The proportion of children suffering from malaria; cough and flu were comparatively higher in the non-fishing than fishing communities. This may have contributed to the increased stunting prevalence in the non-fishing communities. Malaria is among the top 10 causes of morbidity and mortality among the under-five children in Luapula province and Samfya district in particular.

There are some limitations associated with the presented study. Recall bias is identified as a limitation since mothers were expected to recall foods their children had consumed. Secondly, due to the cross-sectional nature of the study, it is not possible to establish cause-effect kind of relationships between variables, and therefore the study is limited to establishing only associations between variables.

Conclusion

Dietary patterns of children were dominated by carbohydrate dense staples (maize, roots and tubers), low consumption of fruits and vegetables, flesh foods, dairy products and eggs. Fish, especially small fish was the most consumed animal source food in the fishing communities, although less than half of the children consumed it. Dietary diversity was not a major factor influencing nutritional status of children 6–59 months, as there was a weak correlation between dietary diversity and the three nutrition indices (HAZ, WAZ and WHZ). Despite children in the non-fishing communities having a higher dietary diversity, a higher proportion of children from these communities still suffered from stunting. Other than dietary diversity, there is need to interrogate whether quantities of food consumed and safety of foods consumed have a bearing on nutritional status. In addition, poor health status of children as demonstrated by presence of illness two weeks preceeding the study, is a key determining factor of undernutrition among children that was established in this study.

Diversification in agriculture and promotion of consumption of nutrient dense locally available foods such as fish should be supported and encouraged. This could contribute towards improved dietary diversity and in the turn improve the nutrition security of young children and other household members. Capacity building for community-based agents and nutrition education in growth monitoring and promotion at and around rural health centres/clinics should integrate and address the issue of adequate diets with regard to frequency and diversity of diets for children under 5 year of age. In this case, multi-sectoral approach and convergence would be appropriate at all levels especially sub district, ward and community levels.

Ethics approval

Ethical clearance was obtained from the University of Zambia Biomedical Research Ethics Committee (Ref. No. 002–04–18). Permission was also sought from respective provincial and district health offices to use the Ministry of Health Growth Monitoring Centres in Namwala and Mkushi districts. A written informed consent was read out to potential study participants and signed by those who agreed to participate in the study. Participants who could not read and write gave a thumb-print on the consent form. Participants who declined to participate in the study, were replaced by those on a replacement list. Prior to starting the data collection exercise, the study objectives were explained to the respondents by the enumerators, who then proceeded to collect data, only from those who agreed to participate in the study.

Declaration of Competing Interest

The authors declare that they have no competing interests.

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